इंटरनेट मानक

Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

“जानने का अधिकार, जीने का अधिकार”
Mazdoor Kisan Shakti Sangathan
“The Right to Information, The Right to Live”

“पुराने को छोड नये के तरफ”
Jawaharlal Nehru
“Step Out From the Old to the New”

IS 8787 (1977): Principles of design, construction and use of liquid-in-glass thermometers [CHD 10: Glassware]

“ज्ञान से एक नये भारत का निर्माण”
Satyanarayan Gangaram Pitroda
“Invent a New India Using Knowledge”

Act Number 22 of 2005
The Indian Parliament
RIGHT TO INFORMATION

Made Available By
Public.Resource.Org

“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”
Bhartṛhari—Nītiśatakam
“Knowledge is such a treasure which cannot be stolen”

BLANK PAGE

BRUTUM FULMEN

IGNORANTIA JURIS NON EXCUSAT

PROTECTED BY COPYRIGHT

IS : 8767 - 1977
(Reaffirmed 2008)

Indian Standard

PRINCIPLES OF DESIGN, CONSTRUCTION AND USE OF LIQUID IN-GLASS THERMOMETERS

UDC 536.513

© *Copyright* 1978

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 5

***September* 1978**

Indian Standard

PRINCIPLES OF DESIGN, CONSTRUCTION AND USE OF LIQUID-IN-GLASS THERMOMETERS

Laboratory Glassware and Related Apparatus
Sectional Committee, CDC 33

Chairman	*Representing*
DR M. SANKAR DAS	Bhabha Atomic Research Centre, Bombay
Members	
SHRI S. V. GULAVANE (*Alternate* to Dr M. Sankar Das)	
SHRI GEORGE ALEXANDER	India Meteorological Department, New Delhi
SHRI S. GOPINATH (*Alternate*)	
DR G. S. BAJWA	Ministry of Defence (R & D)
DR BACHCHAN SINGH (*Alternate*)	
SHRI A. K. BHATTACHARYYA	National Test House, Calcutta
SHRI D. S. CHABHAL	Directorate General of Technical Development, New Delhi
SHRI R. SACHDEV (*Alternate*)	
CHEMIST & METALLURGIST, NORTHERN RAILWAY, LOCO WORKSHOP, LUCKNOW	Ministry of Railways
ASSISTANT RESEARCH OFFICER (CM-I), RDSO, LUCKNOW (*Alternate*)	
DR S. KUMAR	Central Glass & Ceramic Research Institute (CSIR), Calcutta
SHRI MOHINDER NATH	National Physical Laboratory (CSIR), New Delhi
SHRI B. C. MATHUR (*Alternate*)	
SHRI Y. S. NIMBKAR	Haffkine Bio-Pharmaceutical Corporation Ltd, Bombay
DR F. L. SALDANHA (*Alternate*)	
SHRI G. K. RAO	Ministry of Defence (DGI)
SHRI G. S. SHUKLA (*Alternate*)	
BRIG L. D. SACHDEVA	Ministry of Defence (DGAFMS)
DR B. M. SEDALIA	Development Commissioner (Small Scale Industries), New Delhi
SHRI SARUP SIRCAR	The Scientific Indian Glass Co Ltd, Calcutta

(*Continued on page* 2)

© *Copyright* -1978
INDIAN STANDARDS INSTITUTION
This publication is protected under the *Indian Copyright Act* (XIV of 1957) and reproduction in whole or in part by any means except with written permission of the publisher shall be deemed to be an infringement of copyright under the said Act.

(*Continued from page* 1)

Members	*Representing*
SHRI S. G. VERSHNEI	Seraikella Glass Works Ltd, Kandra
SHRI P. P. CHANDRA (*Alternate*)	
SHRI J. K. WAD	Borosil Glass Works Ltd, Bombay
SHRI P. R. RAO (*Alternate*)	
DR G. M. SAXENA, Director (Chem)	Director General, ISI (*Ex-officio Member*)

Secretary

SHRI G. P. SARASWAT
Deputy Director (Chem), ISI

Thermometers Subcommittee, CDC 33 : 2

Convener

SHRI T. D. BANSAL
XV-5352-D, Laddu Ghati,
New Delhi 110055

Members	
SHRI GEORGE ALEXANDER	India Meteorological Department, New Delhi
SHRI S. GOPINATH (*Alternate*)	
SHRI K. D. BAVEJA	National Physical Laboratory (CSIR), New Delhi
SHRI V. P. VASAN (*Alternate*)	
SHRI A. K. BHATTACHARYYA	National Test House, Calcutta
SHRI HARI DATTA	The Ganga Glass Works Pvt Ltd, Balawali
SHRI R. K. GADODIA	Swastik Thermometers Co, New Delhi
DR S. V. GUPTA	Directorate of Weights & Measures, Government of India, New Delhi
SHRI SAMIUL HAQUE (*Alternate*)	
SHRI V. P. GUPTA	Indian Association of Thermometry, Delhi
SHRI P. C. KAPUR	Directorate General of Health Services, New Delhi
SHRI DEEPAK R. KOTHARI	Jintan Clinical Thermometer Co India Pvt Ltd, Surendranagar
SHRI BHARAT R. KOTHARI (*Alternate*)	
MAJ V. G. LAGHATE	Ministry of Defence (DGAFMS)
LT-COL M. K. BAGCHI (*Alternate*)	
SHRI J. C. MAKANI	Ministry of Defence (DGI)
DR J. S. SASTRY	National Institute of Oceanography (CSIR), Panjim
SHRI L. V. G. RAO (*Alternate*)	
SHRI Y. D. SHARMA	Dutta Scientific Works, Delhi
SHRI L. T. P. SINHA	Development Commissioner (Small Scale Industries), New Delhi
SHRI R. SOUNDHIRARAJAN	Directorate General of Technical Development, New Delhi
SHRI B. N. DAS (*Alternate*)	

Indian Standard

PRINCIPLES OF DESIGN, CONSTRUCTION AND USE OF LIQUID-IN-GLASS THERMOMETERS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 27 October 1977, after the draft finalized by the Laboratory Glassware and Related Apparatus Sectional Committee had been approved by the Chemical Division Council.

0.2 Liquid-in-glass thermometers are used in industry, laboratories, teaching institutions, homes, hospitals, etc, wherever measurement of temperature has any significance. As these thermometers are fragile and are designed to serve a large variety of purposes, it is important that they conform to some specific sets of requirements depending on their end use, so that they provide dependable service and are easily replaceable in case of breakage. For this purpose it is considered necessary to lay down general guidelines for formulation of specifications for such thermometers.

0.3 This standard deals with such aspects as design, suitability of materials, construction, graduation and figuring, inscriptions and recommendations for testing, use and storage of thermometers. Some requirements, namely, drainage time, time of response, time constant of a thermometer, jumping of meniscus, non-conventional shapes of bulb, etc, have not been covered in this standard as these are restricted to thermometers having very special applications. Similarly, thermometers provided with attached scales have also not been covered in this standard.

0.4 In the formulation of this standard considerable assistance has been derived from ISO/DIS 386 'Liquid-in-glass laboratory thermometers — Principles of design, construction and use', issued by the International Organization for Standardization (ISO).

1. SCOPE

1.1 This standard specifies principles of design, construction and use of liquid-in-glass thermometers of solid-stem as well as enclosed-stem types.

NOTE — Liquid-in-glass thermometers with attached scales do not fall within the scope of this standard.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 2627-1963* shall apply.

3. TEMPERATURE SCALE

3.1 Liquid-in-glass thermometers shall be graduated in degrees Celsius (°C).

4. CONDITIONS OF IMMERSION

4.0 Liquid-in-glass thermometers shall be graduated for use under any one of the following conditions of immersion.

4.1 Partial Immersion (PI) — The thermometer shall be immersed in the medium up to the immersion line marked on its stem.

NOTE 1 — In case there is no immersion line, the thermometer shall be immersed up to the specified depth of immersion, measured along its axis from the bottom of the bulb.

NOTE 2 — The adopted value of the mean temperature of the emergent column shall be specified to provide reference for calibration and correct use of the thermometer. This value may either be the same for all scale readings; or different values may be specified which may be applicable to different points of the scale.

4.2 Total Immersion (TI) — The thermometer shall be immersed in the medium up to the meniscus of the thermometric liquid in it.

4.3 Complete Immersion (CI) — The entire thermometer shall be immersed in the medium.

5. MATERIALS

5.1 Glass — Liquid-in-glass thermometers shall be made of appropriate thermometric glasses (*see* IS : 4529-1968† and IS : 4610-1968‡).

NOTE — If required prismatic capillary tubing may be used to facilitate reading of temperature.

5.1.1 Glass tubing for the sheath of enclosed-scale thermometers, while complying with other requirements specified in **5.1**, shall have diameters to suit the application.

5.2 Thermometric Liquids

5.2.0 *General* — Thermometric liquids shall comply with the following requirements.

---

*Glossary of terms relating to liquid-in-glass thermometers.

†Specification for glass tubes for medical thermometers.

‡Specification for glass tubes for general purpose and reference thermometers.

5.2.1 They shall neither freeze or tend to freeze nor disintegrate in the temperature range of the thermometer under the pressure, if any, prevailing in it.

5.2.2 They shall neither boil or tend to boil nor vaporize in the temperature range of the thermometer under the pressure, if any, prevailing in it.

5.2.3 They shall be free from dust, moisture or any other contamination likely to interfere with the proper functioning of the thermometer.

5.2.4 Thermometric liquids which wet glass shall also comply with the following additional requirements.

5.2.4.1 Physical properties of the liquids shall be such as to ensure that the drainage time remains within specified limits when the thermometer is cooled.

5.2.4.2 If the liquids are coloured artificially to facilitate reading, the light-fast dye shall not stain the glass and at the same time shall not have tendency to separate or decompose during use.

5.2.5 If alcohol is used as thermometric liquid, it shall comply with the requirements of Special Grade of IS : 321-1964* subject to the following modifications:

a) *Aldehydes and ketones* — Alcohol shall not contain more than 0.02 percent (*m/m*) of aldehydes and ketones, calculated as acetaldehyde (CH_3CHO); and

b) *Amines* — Alcohol shall give no indication of the presence of amines when tested by adding to 10 ml of alcohol, 10 ml of distilled water followed by 2 drops of saturated solution of *p*-nitrophenol in water. Not more than 0.05 ml (1 drop) of 0.01 N sulphuric acid shall be required to discharge any yellow colour produced.

5.2.6 Recommended thermometric liquids and approximate temperature ranges for which they are suitable are as follows:

Thermometric Liquid	*Approximate Temperature Range,* °C
Mercury	– 35 to + 600 (*see* **5.3**)
Mercury-thallium alloy (8.5 percent by mass of thallium)	— 55 to +600 (*see* **5.3**)
Alcohol	– 80 to + 50
Toluene	– 90 to + 50
Technical pentane	– 200 to + 30

---

*Specification for absolute alcohol *(revised)*.

5.3 Gas Filling — In cases where the maximum nominal temperature of a thermometer is to exceed 300°C, a dry inert gas such as nitrogen shall be filled above the thermometric liquid. The pressure of gas shall be enough to prevent boiling or vaporization of the thermometric liquid while the thermometer is in use (*see* **5.2.2**).

6. CONSTRUCTION

6.1 Shape — Unless specified otherwise, liquid-in-glass thermometers shall be straight and their stem shall be, as far as possible, in alignment with the bulb (*see* Fig. 1).

6.1.1 The external cross section of thermometers shall be uniform and circular except when a prismatic capillary tubing is used (*see* **5.1**).

6.2 Stem — The stem of liquid-in-glass thermometers shall be straight as far as possible.

6.2.1 *Top of Thermometer* — The top of thermometers shall have either a smooth finish, hemispherical in shape; or provided with a ring or a button-shaped disc. The top of enclosed-scale thermometers may in addition be provided with a metal or plastic cap cemented to it with or without a ring, button or hook (*see* Fig. 1 and 2).

6.2.1.1 When a ring is provided, it shall be in a plane at right angles to the line of sight when the thermometer is read. Similarly, the button shall be flat, in a plane perpendicular to the axis of the thermometer.

6.2.1.2 The outer diameter of the ring or button, as provided, shall not exceed that of the stem of the thermometer.

NOTE — A nip (small, blunt projection) may be provided near the top of solid-stem thermometer, at its back, to facilitate its mounting on a plaque.

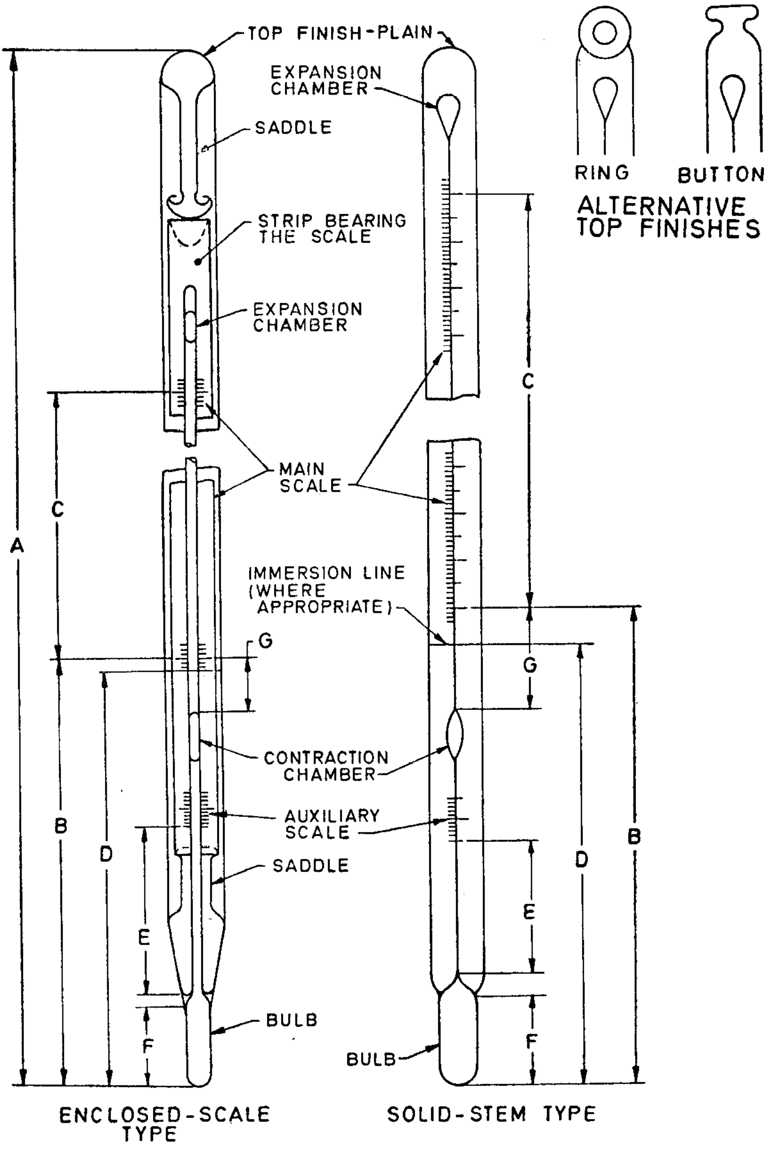
6.2.2 *Capillary Tube* — The inside of the capillary tube shall be smooth.

6.2.2.1 The cross-sectional area of the bore shall not show variation greater than 10 percent of the average value; except at the bulb and the expansion and contraction chambers, if provided.

6.2.2.2 The size of the bore shall be such that when the temperature is rising very slowly, at a uniform rate, the jumping of the meniscus of the thermometric liquid does not exceed a specified limit which in no case shall be more than one-half the smallest scale division.

6.2.3 *Enlargement of Bore* — No enlargement of bore shall be so located as to produce any variation, greater than that prescribed in **6.2.2.1,** in the cross section of the capillary, in the scale range of the thermometer.

6.2.3.1 Unless specified otherwise, there shall be at least 10 mm of unchanged capillary between any enlargement of bore and the nearest graduation line.



A Total length
B Distance from bottom of bulb to lower nominal limit of scale
C Scale length
D Depth of immersion
E Top of bulb funnel to lower nominal limit of auxiliary scale
F Bulb length
G Top of contraction chamber to lower nominal limit of main scale

FIG. 1 GENERAL DESIGN AND TERMINOLOGY OF LIQUID-IN-GLASS THERMOMETERS

6.2.3.2 In the case of partial immersion thermometers, no variation, greater than that prescribed in **6.2.2.1,** in the cross section of the capillary shall be allowed between the immersion line and the nearest graduation line.

6.2.4 *Expansion Chamber*

6.2.4.0 *General* — To minimize the effect of accidental overheating and in exceptional cases of thermometers whose temperature range is below the ambient temperature, an expansion called the 'expansion chamber' or 'safety chamber' is provided at the top of the capillary in alignment with its bore.

NOTE — Overheating for even a short duration is likely to shift the fiduciary point of a thermometer, its whole scale, or even change the calibration data due to severe physical strains developed in the bulb. It, therefore, becomes necessary to give sufficient rest to such a thermometer and re-calibrate it before it is used again.

6.2.4.1 The expansion chamber shall be pear-shaped with its hemisphere at the top.

6.2.4.2 The finish of the expansion chamber shall be such as not to entrap the thermometric liquid.

6.2.4.3 There shall be at least 10 mm of unchanged capillary between the topmost graduation line and the commencement of the widening of the bore for expansion chamber.

6.2.4.4 The capacity of the expansion chamber shall be such that the thermometer shall withstand a temperature at least 50°C in excess of the maximum nominal temperature or an ambient temperature of 60°C whichever is higher.

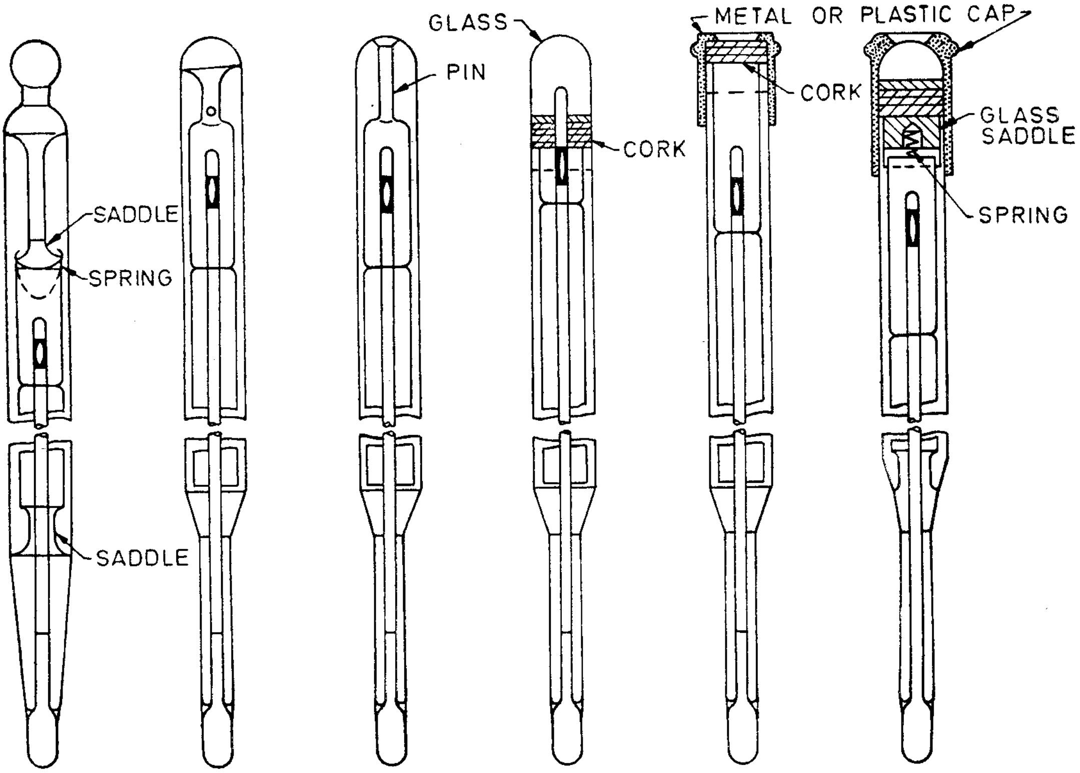
6.2.4.5 If a thermometer is gas-filled the volume of the expansion chamber shall be equivalent to at least 30 mm of unchanged capillary and in any case not less than 50 graduation intervals above the topmost graduation line.

NOTE — This provision is necessary because such thermometers can never utilize the whole expansion chamber because of excessive gas pressure.

6.2.4.6 If desired, approximate minimum capacity of expansion chamber may be specified.

6.2.5 *Contraction Chamber*

6.2.5.0 *General* — To suppress a portion of scale and reduce the drainage time, an expansion called the 'contraction chamber' is provided in the capillary.



2A WITH GLASS SADDLE AND SPRING (FUESS TOP FINISH)

2B WITH FUSED-IN GLASS TUBE (RICHTER TOP FINISH)

2C WITH FUSED-IN GLASS PIN

2D CORK GLASS TOP FINISH

2E CORK AND METAL CAP TOP FINISH

2F WITH GLASS SADDLE AND SPRING IN METAL SUPPORT WITH CAP

FIG. 2 TOP FINISHES AND METHOD OF FIXING THE STRIP BEARING THE SCALE OF ENCLOSED-SCALE THERMOMETERS

As in the Original Standard, this Page is Intentionally Left Blank

6.2.5.1 Contraction chamber shall be provided in a thermometer in alignment with the bore of the capillary and shall be located below the main scale if the minimum nominal temperature is more than 0°C and above it if the maximum nominal temperature is less than 0°C.

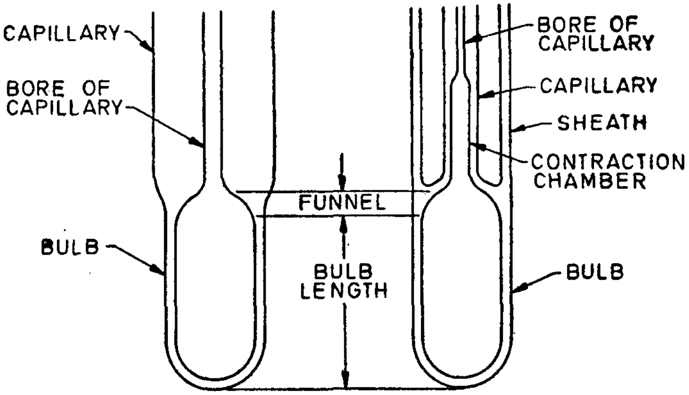
NOTE — In the former case, contraction chamber prevents the thermometric liquid from completely receding into the bulb and in the latter enables the auxiliary (fiduciary) scale to be provided.

6.2.5.2 Contraction chamber shall be in the form of an elongated enlargement and shall be as narrow as possible to facilitate smooth flow of the thermometric liquid and reduce risk of break in the liquid column.

NOTE — A circular cylindrical enlargement with conical ends having a half-apex angle of approximately 20 degrees of arc, and length to diameter ratio of 4 : 1 or 5 : 1 is suitable.

6.2.5.3 In cases where the minimum nominal temperature is above 0°C, the contraction chamber shall be separated from the bulb by a short capillary (*see* Fig. 1).

NOTE — In the case of enclosed-scale thermometers, contraction chamber may also be located just above the bulb (*see* Fig. 3).



3A SOLID-STEM TYPE 3B ENCLOSED-SCALE TYPE

FIG. 3 MEASUREMENT OF BULB LENGTH

6.2.5.4 If the minimum nominal temperature of the thermometer is less than 100°C, the distance (G) *(see* Fig. 1) from the top of the contraction chamber to the nearest graduation line shall be at least 10 mm; and if the minimum nominal temperature is 100°C or more, this distance shall be at least 20 mm.

6.2.5.5 In the case of a partial immersion thermometer the distance (G) shall be measured either to the first graduation line on the main scale or the immersion line, whichever is nearer.

6.2.5.6 If the maximum nominal temperature of a thermometer is less than 0°C, the distance from the bottom of the contraction chamber to the nearest graduation line shall be at least 10 mm.

6.3 Bulb

6.3.0 *General* — Bulbs of liquid-in-glass thermometers are of several shapes. These depend on the end use of a thermometer. The most common shapes are cylindrical, tapered and spherical. In special cases bulbs are made in the forms of spiral and strips also.

6.3.1 Unless specified otherwise, the bulb shall be cylindrical in shape and its outside diameter shall be less than that of the stem of the thermometer, except in cases where this is necessary for special reasons (*see* Fig. 3).

6.3.2 The bulb shall be symmetrical and in alignment with the bore of the capillary.

6.3.3 The bulb shall be fused to the capillary tube in such a way that it permits smooth flow of thermometric liquid.

6.4 Scales

6.4.0 *General* — Every thermometer shall be provided with a scale for indicating temperature. The scale shall be subdivided into smallest scale divisions to cover temperature range(s), and figured as prescribed in **8**.

6.4.1 The scale shall consist of the main scale and also the fiduciary scale, if provided.

6.4.2 The main scale shall cover the temperature range of the thermometer. It shall be divided into smallest scale divisions as prescribed for the thermometer and shall extend on either side of the range by 5 to 10 graduation lines.

6.4.3 The fiduciary scale shall have 5 to 10 smallest scale divisions (corresponding to the main scale) on either side of the fiduciary point which is usually 0°C.

NOTE — In some special cases, for example, in adjustable-range thermometers, the auxiliary scale is provided differently.

6.4.4 In solid-stem thermometers the scale shall be engraved or printed suitably on the stem; and in enclosed-scale thermometers it shall be printed/drawn on a strip, called the 'scale-strip' which shall be placed firmly against the capillary tube inside the sheath of the thermometer.

6.4.5 The scale-strip shall be of a material suitable for the temperature range of the thermometer and compatible with the method of fixing.

NOTE — A suitable method is to fuse the upper end of the scale-strip at the top of the sheath using a glass rod or tube so that the lower end of the scale-strip is free to slide in a suitable saddle (*see* Fig. 2).

7. DIMENSIONS

7.1 The following dimensions of a thermometer (*see* Fig. 1) shall be specified:

a) *Total Length* — Maximum dimension (including bulb and top finish) shall be specified (A).

b) *Scale Length* — Minimum dimension (distance between nominal limits of the main scale) shall be specified (C). For thermometers intended to be read without any optical aid (magnifier), the scale length is generally computed from the number of smallest scale divisions in the main scale of the thermometer on the basis of 0.8 mm per division in solid-stem and 0.6 mm per division in enclosed-scale thermometers. The distance is smaller in enclosed-scale thermometer scale owing to the smaller parallex which is likely in this case.

c) *Scale Position* — If a thermometer has only the main scale, only the minimum distance from the bottom of the bulb to the lower nominal limit of scale shall be specified (B). If the thermometer is provided with the main scale and also the fiduciary scale, the minimum distance from the top of the bulb funnel to the nearest graduation line of the lower scale shall also be specified (E). This distance (E) shall be at least 30 mm if the minimum nominal temperature of the thermometer is more than 0°C and it shall be at least 50 mm if the maximum nominal temperature is less than 0°C.

d) *Diameter of Stem (or Sheath)* — Both maximum and minimum dimension shall be specified.

e) *Diameter of the Bulb* — Only the minimum external diameter shall be specified (*see also* **6.3.1**).

NOTE — For specific purposes, it may be necessary to prescribe tolerances with these dimensions and sometimes even additional dimensions may have to be prescribed.

7.1.1 The following dimensions shall be specified, where necessary:

a) *Distance from the graduation line for maximum nominal temperature to the top of the thermometer* — Minimum dimension shall be specified.

b) *Depth of immersion (in partial immersion thermometers only)* — Dimension with a tolerance of ± 1 mm shall be specified (D).

8. GRADUATION AND FIGURING

8.0 General — The scheme of graduation and figuring for liquid-in-glass thermometers shall be stated in the individual specifications and shall be based on the details given below.

8.0.1 The main as well as the fiduciary scale, where provided, shall have the same graduation interval.

8.0.2 The main scale shall extend beyond the maximum and minimum nominal temperatures by 5 or 10 divisions as may be specified (*see* **6.4.2**).

8.0.3 The fiduciary scale, where provided, shall centre round the fiduciary point (0°C or 100°C), and shall extend on either side equally by 5 or 10 divisions as may be specified (*see* **6.4.3**).

NOTE — This provision enables any changes in the bulb capacity to be taken care of when considered necessary.

8.1 Graduation Lines

8.1.1 Graduation lines shall be at right angles to the axis of the thermometer and shall be clearly and permanently marked. They shall be of equal and uniform thickness which shall not exceed one-fifth of the graduation interval (e) (the axial distance between the centres of two consecutive lines) and also not exceed 0.15 mm in solid-stem and 0.2 mm in enclosed-stem thermometers [*see* **8.1.2.1**(a) and **8.1.2.2**(a)].

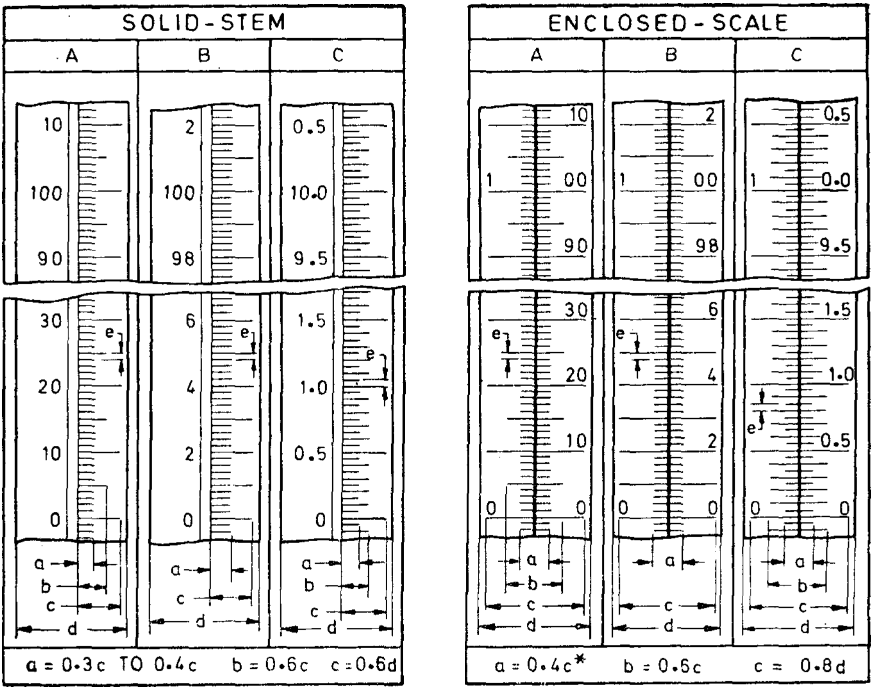
8.1.2 *Length of Graduation Lines* — The graduation lines shall be of three sizes, namely, short, medium and long which shall be related to one another as follows (*see* also Fig. 4).

8.1.2.1 *For solid-stem thermometers* — If e is the graduation interval and d the diameter of stem, the relationship shall be as follows:

a) Thickness of graduation line	0.2 e, but not exceeding 0.15 mm
b) Length of short graduation line, a	0.3 c to 0.4 c
c) Length of medium graduation line, b	0.6 c
d) Length of long graduation line, c	0.6 d

8.1.2.2 *For enclosed-scale thermometers* — If e is the graduation interval and d the width of the scale-strip, the relationship shall be as follows:

a) Thickness of graduation line	0.2 e, but not exceeding 0.2 mm
b) Length of short graduation line, a	0.4 c, but more than the diameter of capillary tube
c) Length of medium graduation line, b	0.6 c
d) Length of long graduation line, c	0.8 d



4A SOLID-STEM THERMOMETERS

4B ENCLOSED-SCALE THERMOMETERS

Graduation Interval = *e* mm

Thickness of graduation lines = 0.2 *e* but not exceeding 0.15 mm in solid-stem and 0.2 mm in enclosed-scale type

Graduation Type A Smallest scale division 0.01, 0.1, 1 or 10°C (1°C shown)

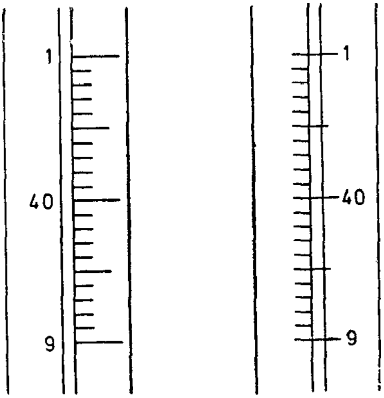
Graduation Type B Smallest scale division 0.02, 0.2 or 2°C (0.2°C shown)

Graduation Type C Smallest scale division 0.05, 0.5 or 5°C (0.05°C shown)

*In any case not less than capillary bore diameter.

FIG. 4 PATTERNS OF GRADUATION AND FIGURING OF THERMOMETERS

8.1.3 *Position of Graduation Lines* — In a solid-stem thermometer, when it is held in a vertical position and viewed from the front, the left-hand ends of all graduation lines shall lie on an imaginary line parallel to the bore. When the thermometer is viewed such that the right-hand ends of short graduation lines align with the left-hand side of the bore, the medium and long lines seem to extend across the bore towards the right (*see* Fig. 5).



5A 5B

FIG. 5 ALTERNATIVE VIEWS OF TYPICAL GRADUATION AND FIGURING FOR SOLID-STEM THERMOMETERS

8.1.3.1 In an enclosed scale thermometer when it is held in a vertical position and viewed from the front, all graduation lines shall extend equally on both sides of the bore of the capillary tube.

8.2 Patterns of Graduation — One of the following three patterns of graduation shall be used for graduating thermometers according to the smallest scale division of the thermometer (*see also* Fig. 4).

8.2.1 If the smallest scale division reads 0.01, 0.1 or 1.0°C, etc, then:

a) every tenth graduation line shall be a long line,

b) there shall be a medium line midway between two consecutive long lines, and

c) there shall be four short lines equally spaced between consecutive medium and long lines (*see* A in Fig. 4A and 4B).

8.2.2 If the smallest scale division reads 0.02, 0.2 or 2.0°C, etc, then:

a) every fifth graduation line shall be a long line, and

b) there shall be four short lines equally spaced between two consecutive long lines (*see* B in Fig. 4A and 4B).

8.2.3 If the smallest division reads 0.05, 0.5 or 5.0°C, etc, then:

a) every tenth graduation line shall be a long line,

b) there shall be four medium lines equally spaced between two consecutive long lines, and

c) there shall be one short line midway between two consecutive medium lines or between consecutive medium and long lines (*see* C in Fig. 4A and 4B).

8.3 Figuring

8.3.1 In solid-stem thermometers all the figures shall be placed either slightly to the left or to the right of the lines, as preferred (*see* Fig. 4A and 5), in such a manner that an extension of the line to which they refer would bisect them.

8.3.2 In enclosed-scale thermometers the figures shall be placed immediately above the line to which they refer (*see* Fig. 4B).

8.3.3 The figures may be placed either at right angles or parallel to the bore of the thermometer as preferred.

8.3.4 When the figures are placed at right angles to the bore the unit digits of the figures shall be in a line parallel to the bore.

8.3.4.1 When the figures are placed parallel to the bore (horizontal reading thermometers), all the figures shall lie along a line parallel to the bore.

8.4 Sequence of Figuring — Every tenth graduation line shall be figured; thus the series of figures shall be:

a) 0.1, 0.2, 0.3,........°C for the smallest scale division of 0.01°C,
b) 1, 2, 3,...............°C for the smallest scale division of 0.1°C,
c) 10, 20, 30,...........°C for the smallest scale division of 1°C,
d) 0.2, 0.4, 0.6........°C for the smallest scale division of 0.02°C,
e) 2, 4, 6,............. °C for the smallest scale division of 0.2°C,
f) 20, 40, 60,..........°C for the smallest scale division of 2°C,
g) 0.5, 1.0, 1.5,........°C for the smallest scale division of 0.05°C
h) 5, 10, 15,............°C for the smallest scale division of 0.5°C
j) 50, 100, 150,........°C for the smallest scale division of 5°C.

8.4.1 Graduation lines at 0, 10 or 100°C may be emphasized, for example, by full figuring.

8.5 Immersion Line — An immersion line shall be engraved or marked on partial immersion thermometers at the point to which the thermometer is intended to be immersed while in use. Alternatively, immersion depth may be marked at the back of the thermometer.

8.5.1 In solid-stem thermometers the immersion line shall be engraved or marked on the stem. If the immersion point is below the lowest graduation line of the main scale, the immersion line shall be a ring carried completely round the stem. If the immersion line is above the lowest graduation line of the main scale, it shall be confined only to the back of the stem.

8.5.2 In enclosed-scale thermometers the immersion line shall be engraved or marked on the back of the scale-strip.

8.6 Datum Line — In enclosed-scale thermometers, where the scale-strip is not fused at the top of the thermometer, a permanent datum line of thickness comparable with that of the graduation lines, shall be marked on the right-hand side of the sheath on a level with the lowest (or the lowest figured) graduation line so that any displacement of the scale may be easily noticed.

8.7 Pigment Filling — The Pigment filling shall remain in the engraved graduation lines, figures and inscriptions on a thermometer under normal conditions of use.

9. LIMITS OF ERRORS

9.0 General — All liquid-in-glass thermometers shall be tested and calibrated under prescribed conditions for their use, with reference to the primary standard platinum resistance thermometers of the National Physical Laboratory, New Delhi, or with a secondary standard thermometer *(see* IS : 4825-1968*) calibrated against it, using the method of calibration prescribed in IS : 6274-1971†.

9.1 Accuracy — The maximum permissible scale error shall be specified and shall not be more than 1 smallest scale division when the thermometer is tested in accordance with **7.1** of IS : 6274-1971† under precisely defined conditions.

NOTE — For thermometers having smallest scale divisions of 0.01, 0.02, 0.05°C or having maximum nominal temperatures above 300°C, a larger error is permitted and shall be specified.

9.2 Stability — In a thermometer the changes in the indication corresponding to a temperature of 0°C (or other reference point) shall not be greater than that specified in the relevant specification when the thermometer is tested in accordance with **7.2** of IS : 6274-1971†, under precisely defined conditions after being subjected to a temperature corresponding to the maximum nominal temperature.

9.3 Interval Error — The maximum permissible algebraic sum of the calibration corrections in a stated interval (temperature span) shall be specified. When the intervals are not specified they shall be assumed to start from the minimum nominal temperature on the main scale.

---

*Specification for laboratory and reference thermometers.

†Method of calibrating liquid-in-glass thermometers.

10. INSCRIPTIONS

10.1 The following inscriptions, as may be appropriate, shall be specified to be legibly and permanently marked on liquid-in-glass thermometers:

a) The symbol 'C' or '°C' to indicate the temperature scale;

b) Immersion; if required:

  1) for thermometers to be used at partial immersion, the depth of immersion shall be indicated and if the thermometer is adjusted for a single average temperature of the emergent liquid column, say, 100°C (*see* **4.1**), this may also be marked on the stem or for enclosed-scale thermometers on the back of the scale-strip, for example, 'PI-75 mm 100°',

  2) for thermometers to be used at total immersion — 'Total' or abbreviation 'TI',

  3) for thermometers to be used at complete immersion — 'Complete' or abbreviation 'CI';

NOTE — If a thermometer does not have any of the three inscriptions, it shall be assumed that the thermometer is for use at total immersion.

c) The symbol 'GF' in case the thermometer is gas filled;

d) The glass from which the bulb is made should preferably be identified by means of a coloured stripe or stripes, or by an inscription on the thermometer;

e) IS number and schedule mark as given in the relevant specification; and

f) Vendor's and/or manufacturer's name or his registered trade-mark, if any.

10.1.1 The thermometers may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act, and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions, under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

11. USE OF LIQUID-IN-GLASS THERMOMETERS

11.1 Selection of Thermometers — Selection of a thermometer depends on the specific application in view and calls for consideration of the following:

a) Type of thermometer, that is, solid-stem or enclosed-scale;

b) Conditions of immersion required, that is, partial, total or complete;

c) Temperature range, smallest scale division and accuracy; and

d) Dimensions which may be suitable.

11.1.1 A convenient way to refer to a thermometer is to specify the ISI Specification number and schedule mark which covers it.

11.2 Calibration and Use of Thermometers — Suitable methods for calibration and use of thermometers are prescribed in IS : 6274-1971*.

11.3 Storage of Thermometers — It is advisable to store liquid-in-glass thermometers in a cool place to prevent partial vaporization of the thermometric liquid. The containers should have suitable supports or saddles for each thermometer to save them from any mechanical injury and thermal strain. There should be some cushioning material or blank space below the bulb and the top of each thermometer.

---

*Method of calibrating liquid-in-glass thermometers.